

# ***SPIN measurement with FVTX***

**Xiaorong Wang  
NMSU/RBRC**

- ❑ **Introduction**
- ❑ **FVTX status**
- ❑ **Open heavy flavor Single Spin asymmetry**
- ❑ **Forward W background reduction with FVTX**
- ❑ **Summary and outlook**



Xiaorong Wang, NMSU/RBRC, Nov 7, 2012



# Introduction

## □ 2012 Fall: Assistant professor in New Mexico State University and RBRC Fellow

### □ Previous work:

- Muon Arm data analysis
- FVTX simulations

### □ Physics interest:

- Single spin asymmetry through heavy-flavor channel (J/psi, open Heavy Flavor)
- DeductW background using new installed FVTX

### □ NMSU PHENIX team

- Senior Faculty: Steve Pate and Vasili Papavasilliou
- Students: Elaine Tennant: FVTX assembling

Abraham Meles: W background

Darshana Perera: Drell – yan  $A_{LL}$

Joengsu Bok: b and c separation

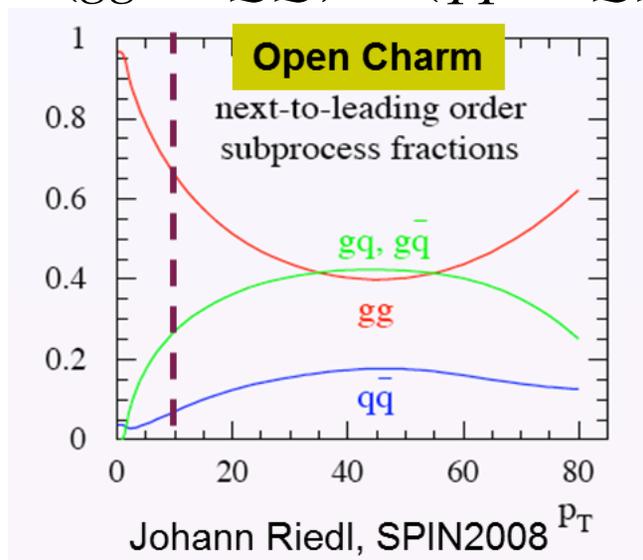
- Postdoc: Feng Wei



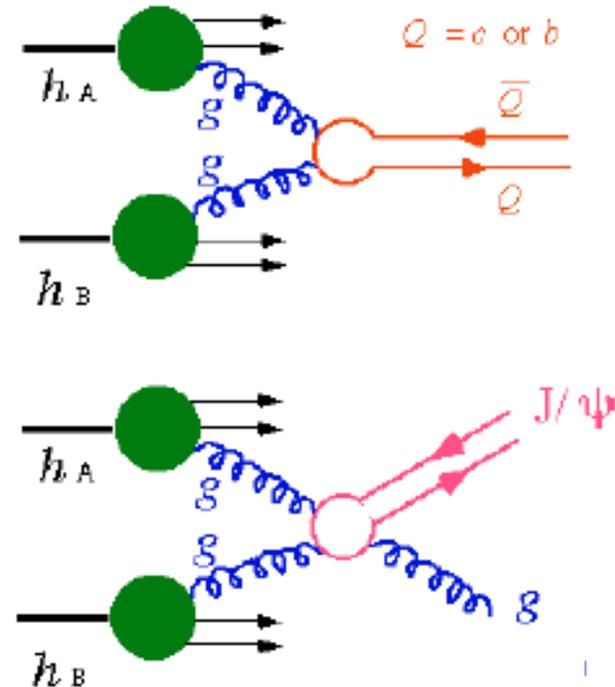
# Open heavy flavor Single Spin asymmetry

## □ Gluon Fusion dominates at NLO

$$\sigma(gg \rightarrow Q\bar{Q}) : \sigma(q\bar{q} \rightarrow Q\bar{Q})$$



## Gluon Fusion



## □ Gluon Sivers function and $A_N$

## □ Experimental challenges

- Need trigger for single muons
- Need FVTX to identify muons from heavy flavor decays.

# Heavy Quark TSSA at RHIC

## Twist-3 tri-gluon correlation funs

$$P_h^0 \frac{d\sigma^{3\text{gluon}}}{d^3 P_h} \simeq \frac{\alpha_s^2 M_N \pi}{S} \epsilon^{P_h p m S \perp} \sum_{f=c\bar{c}} \int \frac{dx'}{x'} G(x') \int \frac{dz}{z^3} D_a(z) \int \frac{dx}{x} \delta(\tilde{s} + \tilde{t} + \tilde{u}) \frac{1}{\tilde{u}} \left[ \delta_f \left( \frac{d}{dx} O(x) - \frac{2O(x)}{x} \right) \hat{\sigma}^{O1} + \left( \frac{d}{dx} N(x) - \frac{2N(x)}{x} \right) \hat{\sigma}^{N1} \right].$$

where  $O(x) \equiv O(x, x) + O(x, 0)$ ,  $N(x) \equiv N(x, x) - N(x, 0)$ .

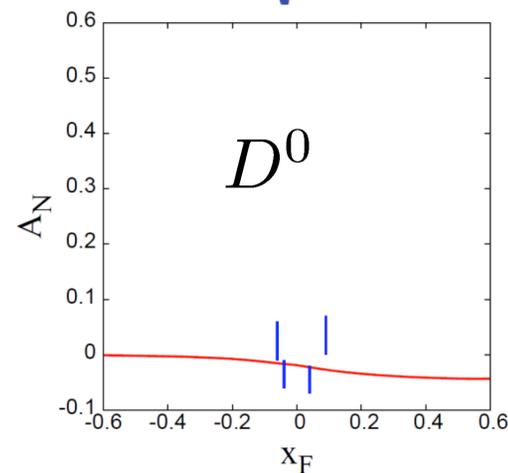
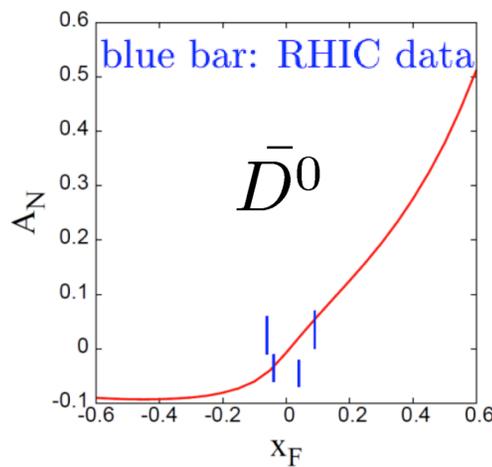
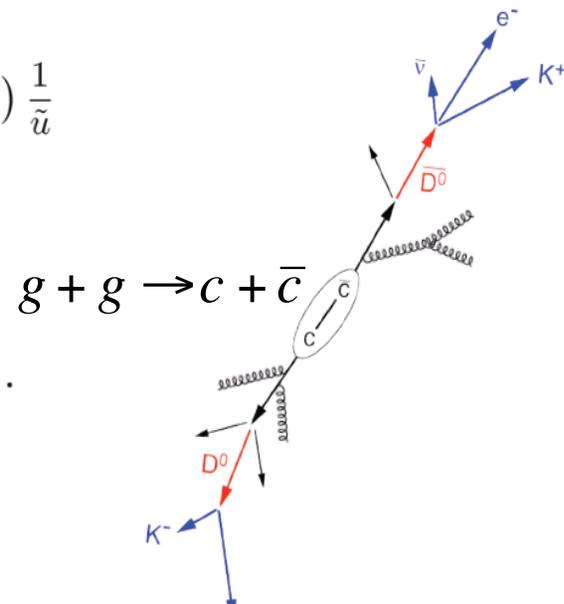
$$A_N(D) \stackrel{?}{\neq} A_N(\bar{D})$$

Model 1:

$$O(x) = 0.004xG(x)$$

Koike *et. al.* (2011)

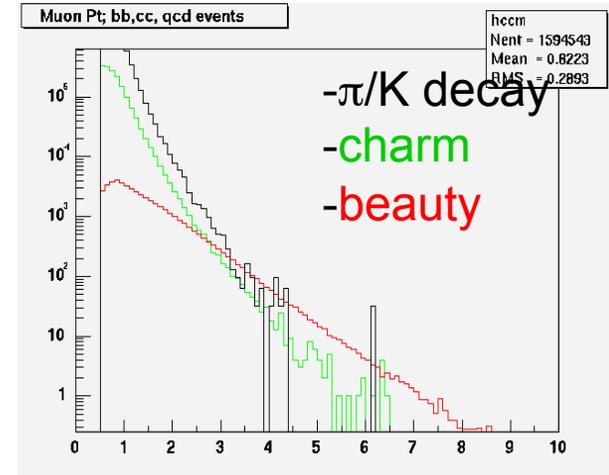
Kang, Qiu, Vogelsang, Yuan (2008)



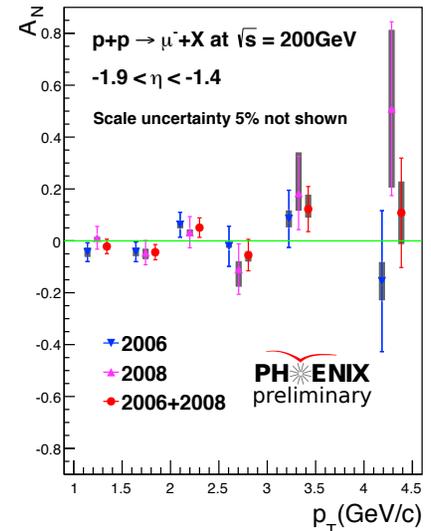
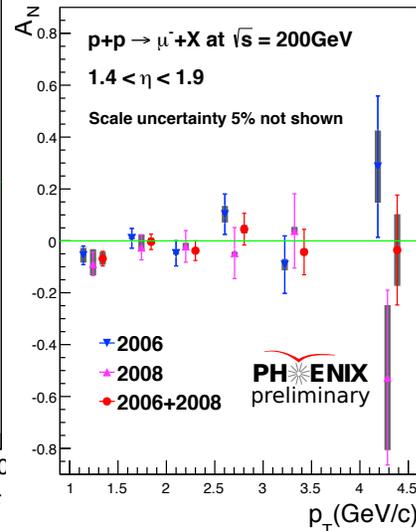
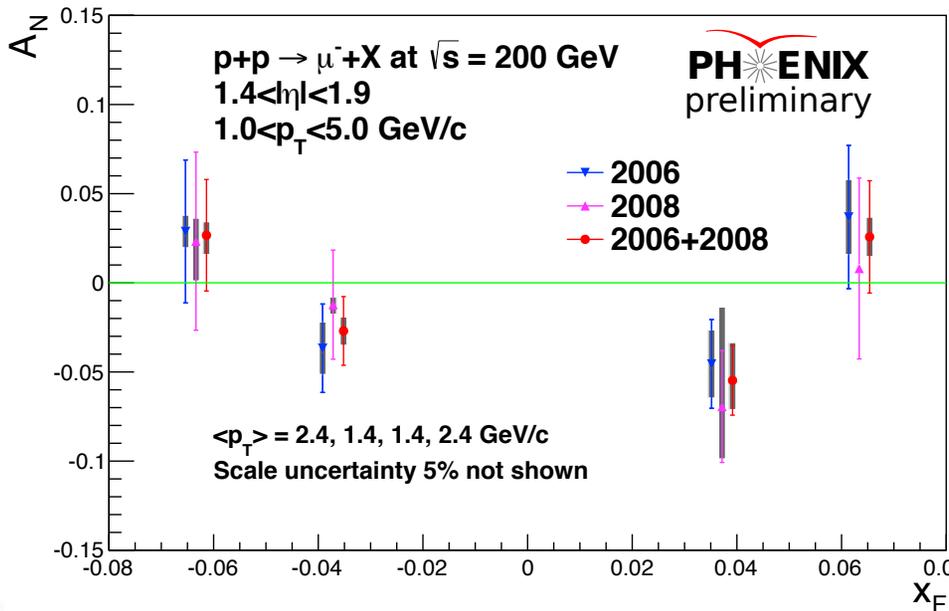
# Open Heavy Quark $A_N$

## Forward Muon arms $1.2 < |\eta| < 2.4$

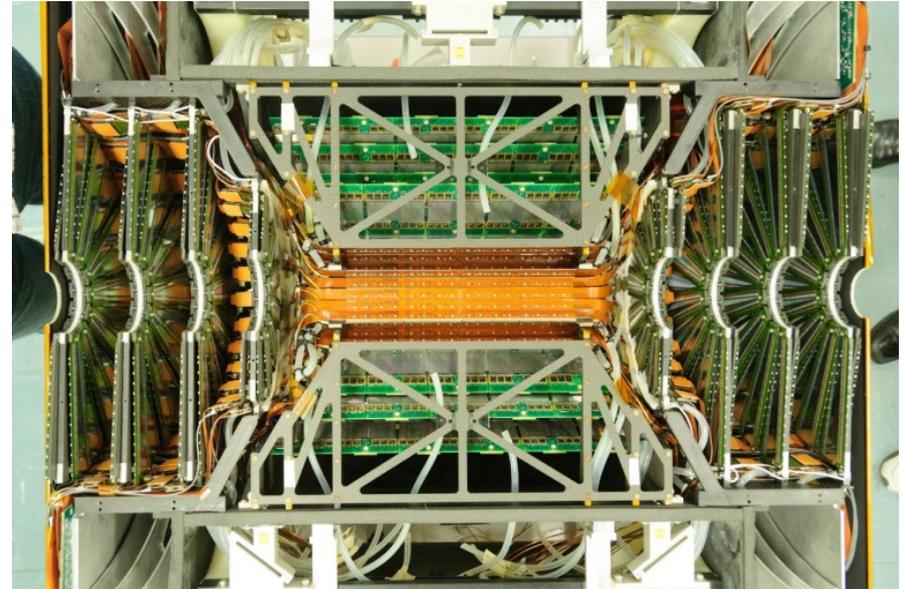
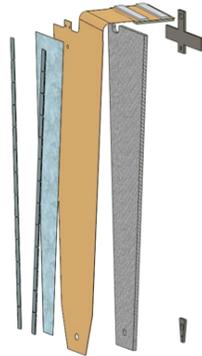
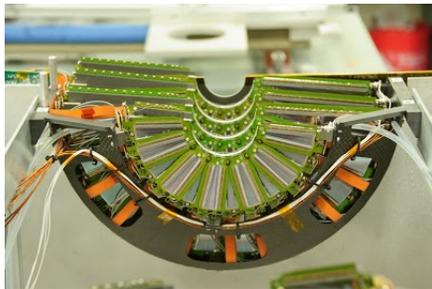
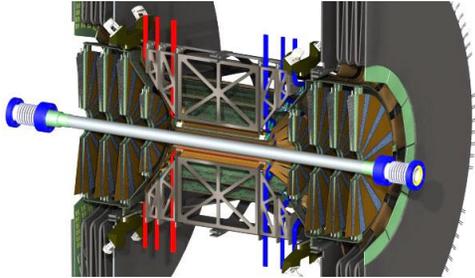
- Run6, 8 data
- Run12 work in progress
- Systematics limited



F. Wei, X, Wang (2012)



# Forward Silicon Vertex Tracker



- $1.2 < |\eta| < 2.4$  , Two Arms, Four tracking stations with full azimuthal coverage,  $18.5 \text{ cm} < |z| < 38 \text{ cm}$
- $75 \mu\text{m}$  pitch strips in radial direction,  $3.75^\circ$  staggered phi strips
- Radiation length  $< 2.4\%$ /wedge to minimize multiple scattering
- PHENIX FVTX Upgrades: completed 2011,
- Over 90% of Detector is operational in 2012 (*pp*, *UU*, *CuAu*)

# FVTX Commissioning and Current Status

**FVTX Closeout Meeting (April 23, 2012 BNL)**

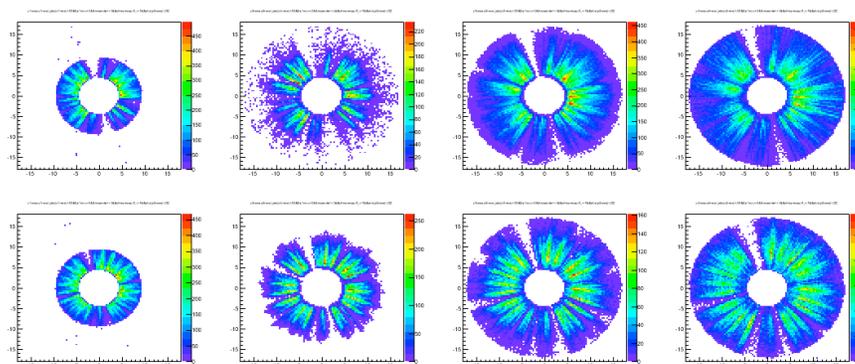
**(F)VTX Performance Review (July 16, 2012 BNL)**

**FVTX software workshop (Oct 29-31, 2012 NMSU)**

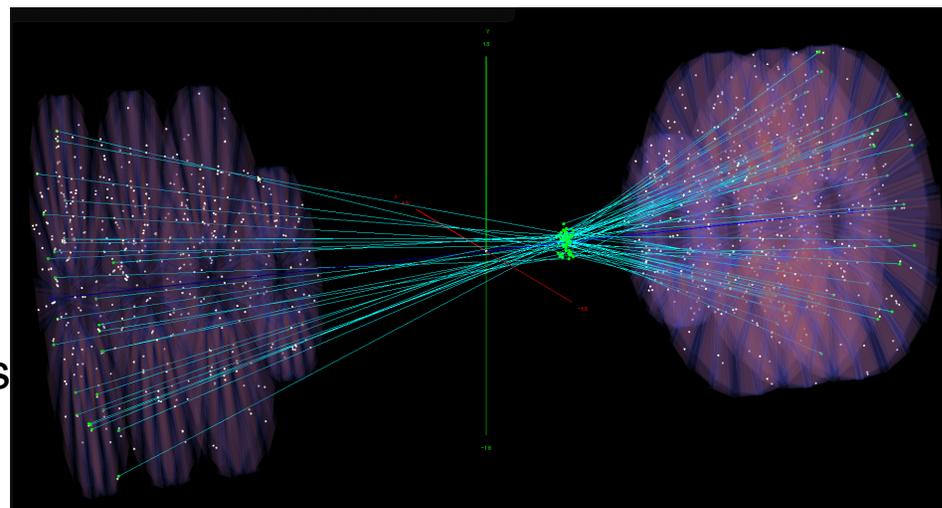
## Summary of FVTX Status in 2012

- Over 90% of Detector is operational and Detector performance design specifications have been met.
- Software readiness
  - PHENIX official ndst and picodst framework for simulations and real data. Done
  - Track fitting with MuTr: done
  - Track fitting with VTX hits: fine tune
  - Alignment: fine tune
- New trigger for open heavy flavor physics

Radiographs from reconstructed tracks

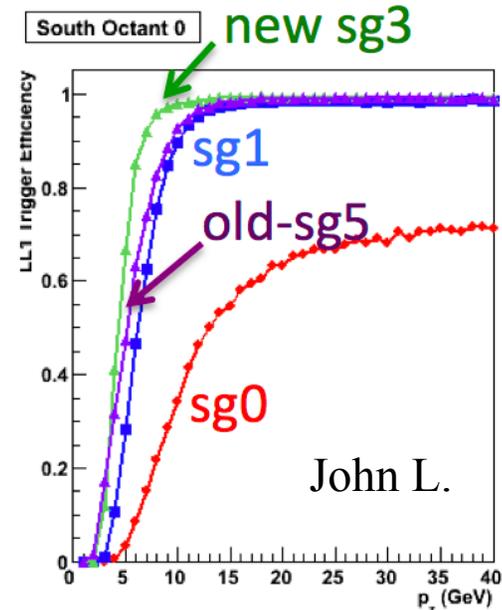
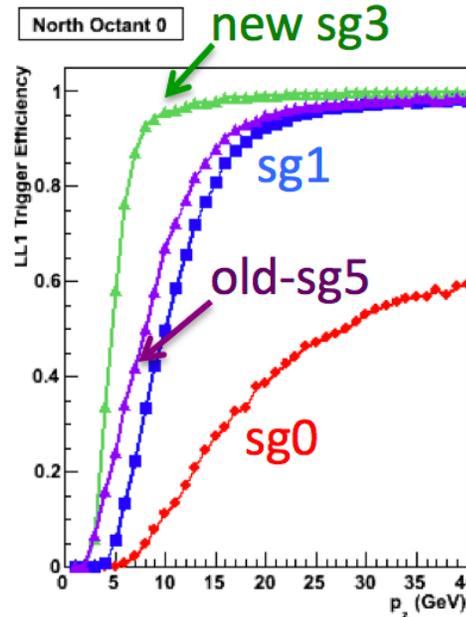
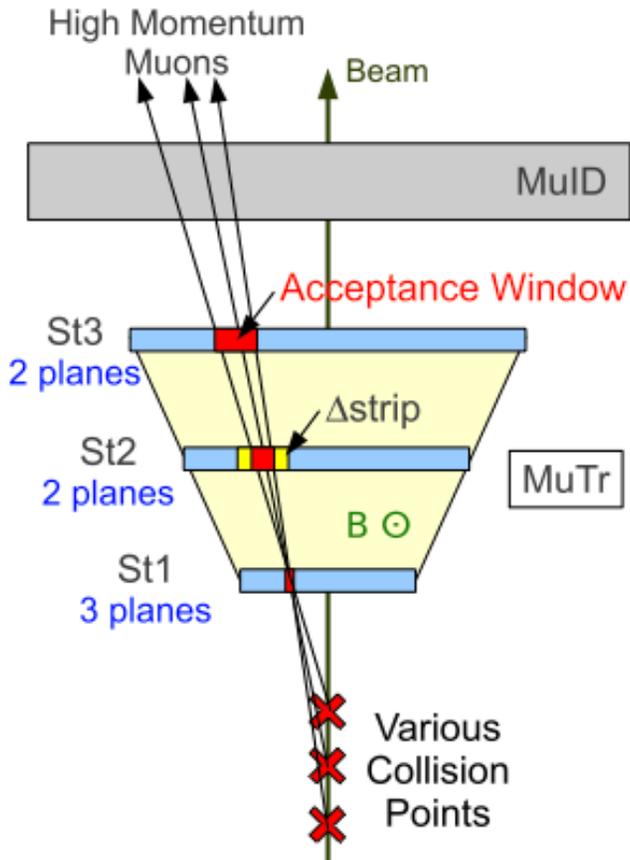


FVTX Event Display



# Heavy Flavor SG3 trigger Development

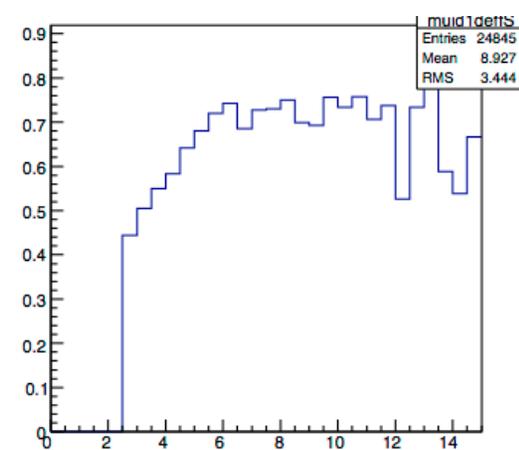
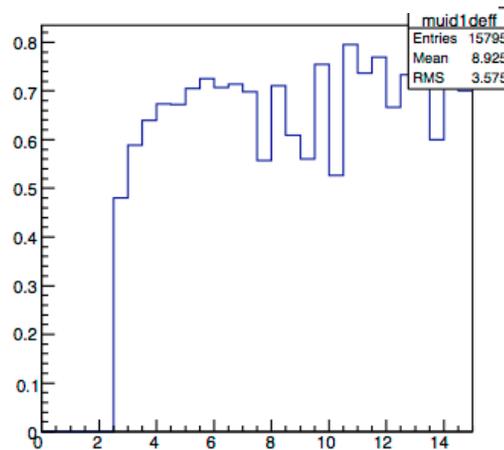
X. Jiang and X. Wang



John L.

North SG3 && MuID

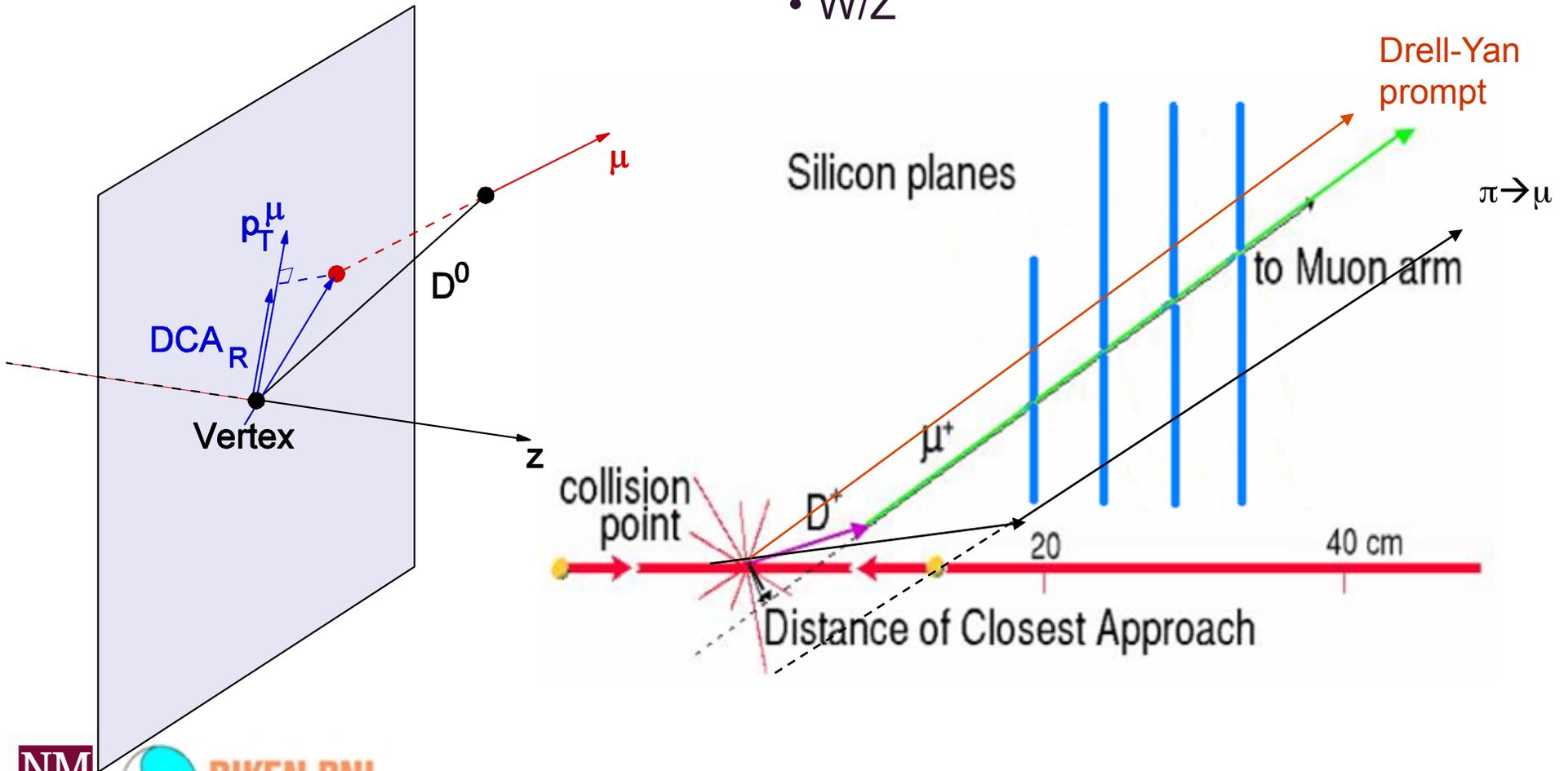
South SG3 && MuID



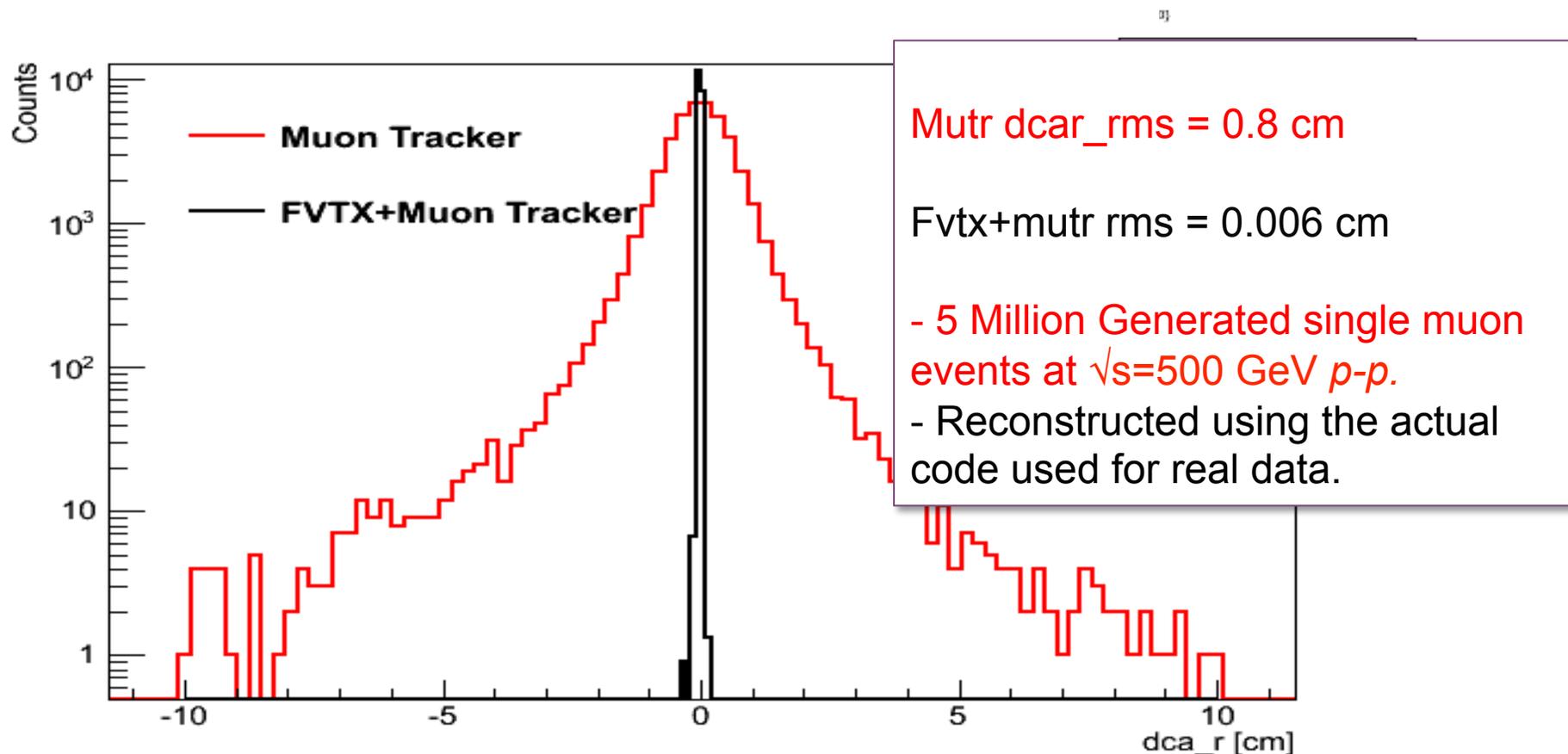
# Much Improved Forward Muon Probes

Projected reconstructed vertex onto reconstructed  $p_T$

- Charm/Beauty Measurements
- Drell-Yan,  $J/\psi$  ...
- W/Z

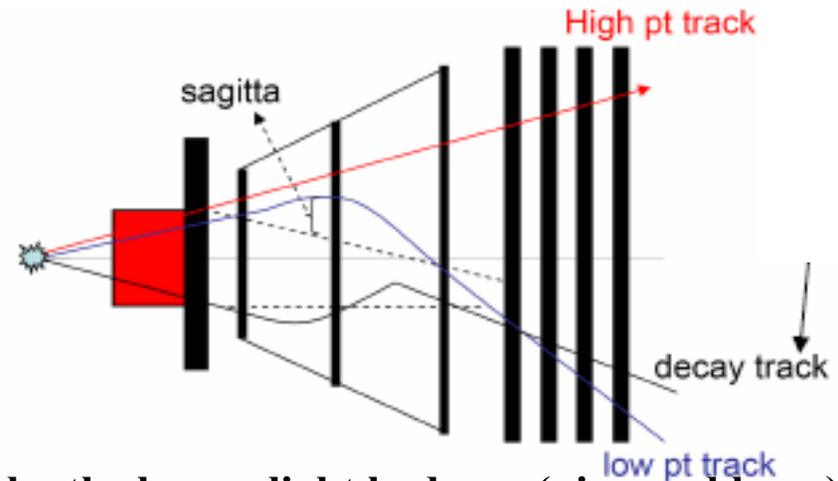


# Improved $W$ signal $DCA_r$ measurement

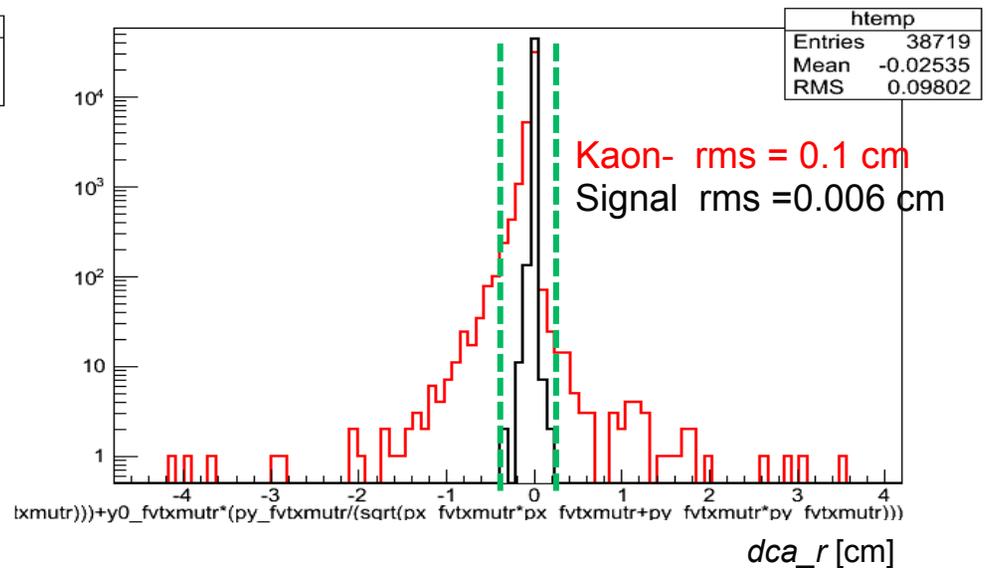
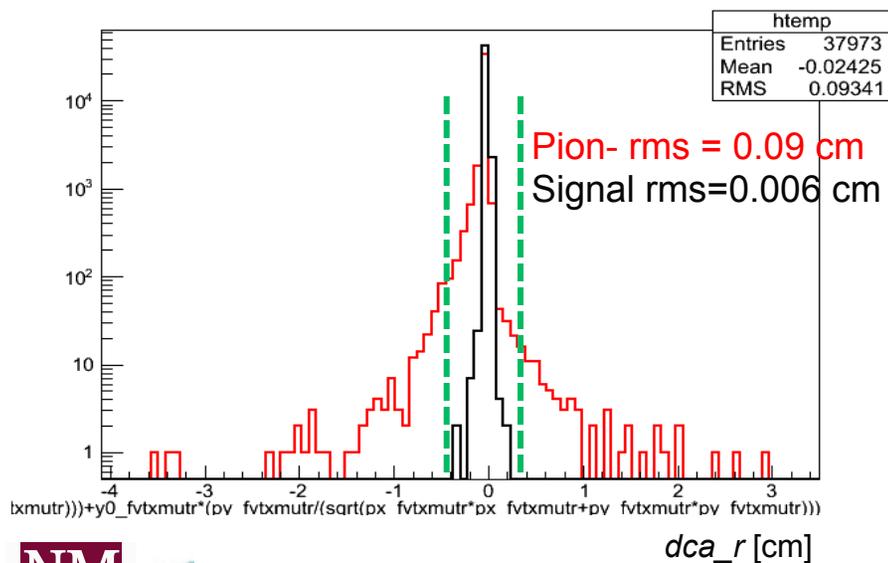


# High $p_T$ background from low $p_T$ hadrons

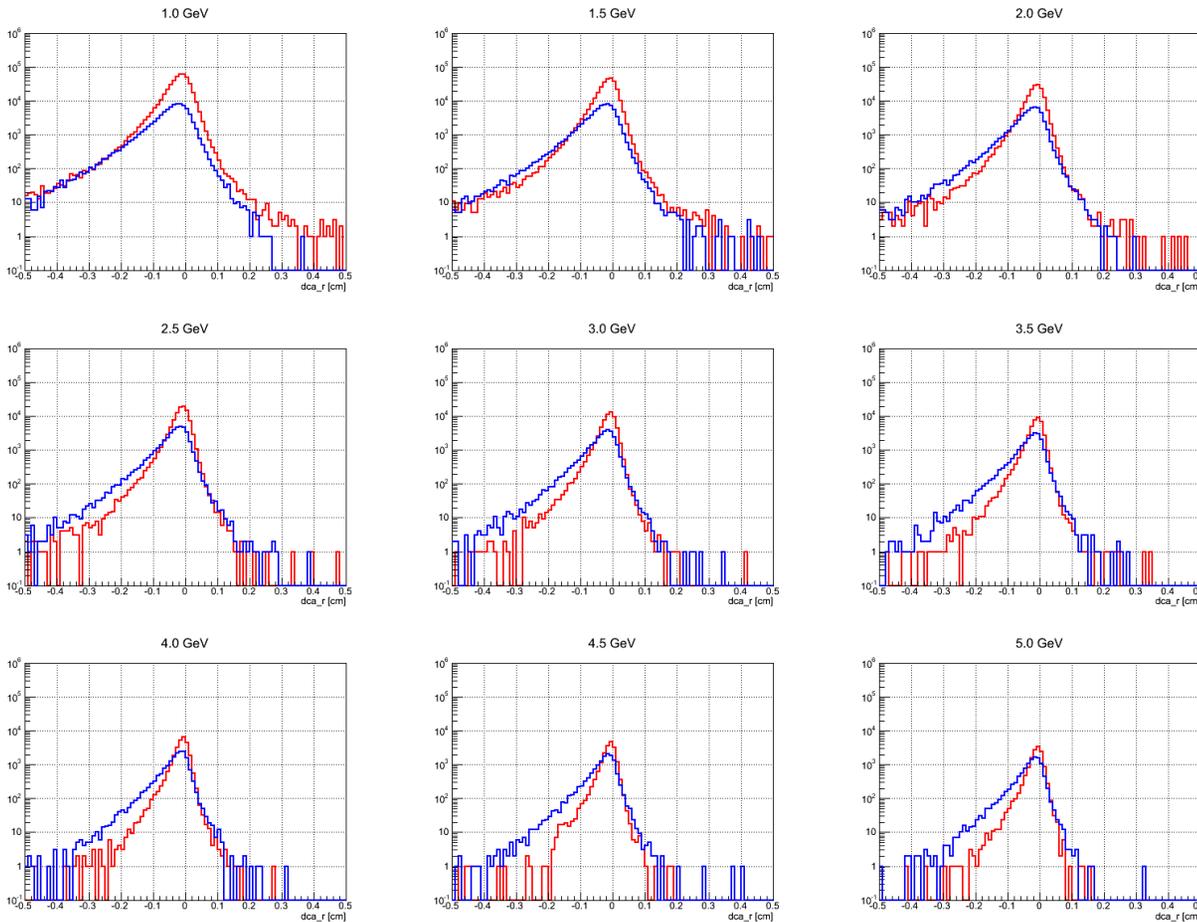
Muons from hadrons tracks could be (mis)reconstructed to higher momentum, because of their kink trajectory accidentally matching to straight hit points in the MuTr. (fake high  $p_T$  muons).



The background in  $W$  production is dominated by the low  $p_T$  light hadrons (pion and kaon)

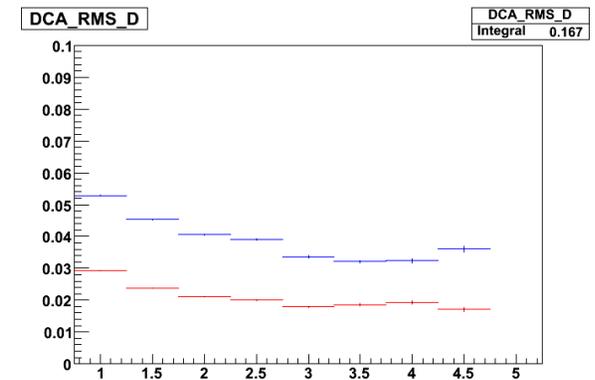


# B and D DCAR $pp$ 510 GeV

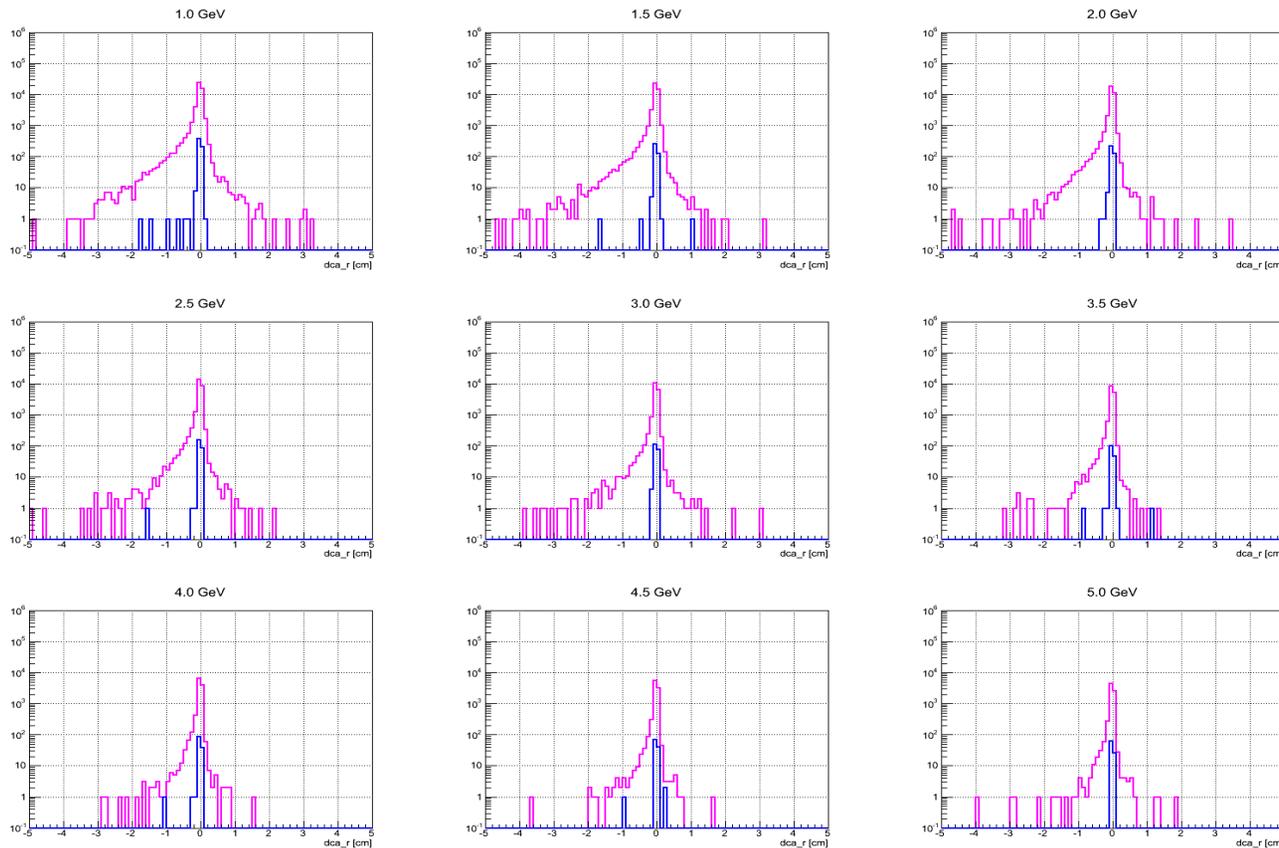


Blue : 50 mil B events  
Red : 900mil D events

Using actual reconstruction code used for real data



# $\pi^\pm$ DCAR<sub>R</sub>



190mil  $\pi^\pm$  generation

Blue : stopped hadron  
magenta : deeply penetrating  
(decay muon including punch-through)

$DCAR(\text{background}) > 10 \times DCAR(\text{muons from B,D})$

## SUMMARY and Outlook

- **Newly installed FVTX detector has successfully commissioned into PHENIX data taking. New heavy flavor trigger (SG3) is implemented.**
- **Heavy flavor is unique channel to understand gluon Sivers. Run 8 new preliminary result consistent with Run6. Run12 heavy flavor  $A_N$  is working in progress.**
- **Addition to improve heavy flavor measurement, FVTX will make contribution to improve signal to background ratio for W measurement within 10 cm vertex range. Run12 W background study is working in progress.**